



The genus *Anisancylus* Pilsbry, 1924 (Planorboidea, Ancylineae) in South America: species distribution and new records

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Abstract

Information on the distribution of *Anisancylus* Pilsbry, 1924 in South America is provided. For first time, we recorded *A. dutrae* (Santos 1994) in Minas Gerais state and 2 new localities in northeastern Brazil. *Anisancylus obliquus* (Broderip & Sowerby, 1832) is widely distributed in Chile, Peru, central and southern Argentina, Uruguay and southern Brazil while *A. dutrae* is restricted to Brazil. This freshwater genus shows a disjunct distribution in South America that could be explained by tectonics and evolution of the basins. To understand this peculiar distributional pattern, additional studies should be performed combining biogeographic and phylogeographic analyses.

Key words

Mollusca; Gastropoda; freshwater snails; limpets; watersheds; Neotropical Region.

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Introduction

Anisancylus was established by Pilsbry (1924), based on the morphology of the shell's apex and the radula. He designated as type species *Ancylus obliquus* Broderip & Sowerby, 1832 (now *Anisancylus obliquus*), from Chile. *Anisancylus* is endemic to the Neotropical region and is composed of 2 nominal species: *Anisancylus dutrae* (Santos, 1994) and *A. obliquus*. Both species are common in lotic environments, under stones or on their surfaces, and, rarely, on fallen leaves (Santos 1994, Ovando et al. 2014).

Anisancylus dutrae is restricted to northeastern Brazil (Santos 2003b) while *A. obliquus* has a widespread distribution with records in Brazil (Hubendick 1964, Ohlweiler and Lanzer 1993, Lanzer 1996, Santos 2003a, 2003b, Simone 2006), Chile (Biese 1948; Ohlweiler and Lanzer

1993; Santos 2000; Zarges 2006), Peru (Ohlweiler and Lanzer 1993), Uruguay (Formica Corsi 1900, Ohlweiler and Lanzer 1993, Scarabino 2004) and Argentina (Fernández 1981, Rumi et al. 2006, Rumi et al. 2008, Ovando et al. 2014). The systematics of *Anisancylus* has changed somewhat over time. Hubendick (1964) and Lanzer (1994, 1996) synonymized *Anisancylus* with *Gundlachia* L. Pfeiffer, 1849 based on the general similarity of the shell morphology and reproductive system. Santos (2000, 2003b) analyzed the detailed morphology of the shell and some anatomic characters (mantle pigmentation, muscle impressions, adhesive areas, reproductive and muscle systems, radula and buccal mass), concluding that *Anisancylus* was a valid genus. At present, *Anisancylus* is 1 of 8 Neotropical genera of Ancylineae (freshwater limpets of the family Planorbidae).

As goal of the present study, we update the information of the distribution of *Anisancylus* species in South America based on material housed in scientific collections, records from the literature and material collected from several localities in Brazil.

Methods

This study was based on a literature review (using Scielo, Scopus and Web of Sciences data bases), material deposited in the following institutional collections: Academy of Natural Sciences of Drexel University, Philadelphia, Pennsylvania, USA (ANSP); Instituto de Biodiversidad Neotropical, Tucumán, Argentina (IBN); Museo Nacional de Historia Natural de Montevideo, Uruguay (MNHN); Museo Nacional de Historia Natural de Santiago de Chile, Chile, (MNHN); Museo de Zoología de la Universidad de Concepción, Chile (MZUC); Instituto Oswaldo Cruz, Rio de Janeiro, Brazil (CMI); National Museum of Natural History, Washington, DC, USA (USNM); Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil (Col. Mol. UERJ) and material collected in various localities from Brazil.

Geopolitical boundaries and watersheds were used as overlays to produce the distribution map based on 107 records (16 records from Argentina, 18 from Brazil, 57 from Chile, 3 from Peru and 13 from Uruguay) (Table 1). To produce the map, GIS software was used taking in account layers of administrative areas, basins and water lines (rivers). Layers of administrative areas and water lines of Argentina, Chile, Uruguay and Brazil were obtained from DIVA resource (<http://www.diva-gis.org/gdata>). Localities without exact geographic coordinates in the original source were georeferenced using the GEO-Locate web application (<http://www.museum.tulane.edu/geolocate/web/webgeoref.aspx>) and Google Earth™. The identifications of specimens collected were corroborated with original descriptions, type material and morphological characters proposed in Santos (2003b). Shell microsculpture was analyzed under SEM in the Museu Nacional da Universidade Federal do Rio de Janeiro.

Results

Anisancylus obliquus (Broderip & Sowerby, 1832)

Ancylus obliquus Broderip and Sowerby 1832: 202.

Ancylus gayanus d'Orbigny 1837: 356.

Anisancylus gayanus obliquus Biese 1948: 229.

Ancylus gayanus var. *maximus* Biese 1948: 231.

Anisancylus oblicuus [sic] — Castellanos 1982: 102; Castellanos and Miquel 1991: 11, fig. 5.

Gundlachia gayana — Castellanos and Miquel 1991: 11, fig. 5.

Gundlachia obliqua — Hubendick 1967: 36; Ohlweiler and Lanzer 1993: 121; Lanzer 1996: 175.

Anisancylus obliquus — Fernández 1981: 107; Santos 2000: 995; Santos 2003b: 206; Rumi et al. 2006: 207; Simone 2006: 112; Rumi et al. 2008: 83; Núñez et al. 2010: 52; Martello 2014: 37.

External features. Patelliform, high and rounded shell. Apex projected and inclined towards the right side and

posteriorly. Apex sculpture with irregular pits, radial lines and central deep apical depression (Figs 1–3). Animal with 3 muscular impressions, 2 anterior and 1 right posterior; right anterior muscular impression more elongate than the left and posterior. Adhesive areas between the right anterior muscle and posterior. Mantle pigmentation varies from dark brown to black. Radula: rachidian tooth elongated shape with a major cusp and 2 or 3 lower cusps on each side (Santos 2003b, Ovando et al. 2014).

Type locality. "In Chili in rivulis, saxis adhaerens" (Broderip and Sowerby 1832). Santos (2003) established Valparaíso, Chile as the type locality.

Distribution (Fig. 7). **ARGENTINA: Córdoba** (Rumi et al. 2006, Rumi et al. 2008, Ovando et al. 2014); Cabana (Ovando et al. 2014); Los Reartes River, Athos Pampas (Ovando et al. 2014); Las Rosas, Primero River (Ovando et al. 2014); Los Reartes River (Col. Mol. IFML 16269, Col. Mol. BDAD 195); Calamuchita (Ovando et al. 2014); Primero River (Ovando et al. 2014); Yacanto stream (Col. Mol. IFML 16270, Col. Mol. BDAD 167); La Tablada, Primero River (Ovando et al. 2014); San Roque River (Ovando et al. 2014); Anisacate River near to La Bolsa (Col. Mol. IFML 16267, Col. Mol. BDAD 191); La Cumbrecita, del Medio River (Col. Mol. IFML 16268); del Medio River (on way to Santa María from Calamuchita) (Col. Mol. BDAD 193). **Río Negro** (Rumi et al. 2008); Niño stream, San Carlos de Bariloche (Ovando et al. 2014); Collón Cura River, Piedra del Águila (CMI 1903); San Martín de los Andes (CMI 1912). **BRAZIL: Southern Brazil** (Santos 2003b, Zarges 2006). **Rio Grande do Sul** (Simone 2006): Santana do Livramento (Lanzer 1996); Ibirapuitã River, Santana do Livramento (Ohlweiler and Lanzer 1994); Chapéu stream, Coxilha São Rafael, Cerro do Chapéu, Estância São Roberto, Quaraí (Ohlweiler and Lanzer 1993, Lanzer 1996); Alegrete (Ohlweiler and Lanzer 1993, Lanzer 1996); Toropi River Basin, Toropi (Martello et al. 2014). **CHILE** (ANSP 124236, USNM 573469): **Aconcagua**: Estero San Isidro, Quillota; Estero San Pedro, Quillota (Ohlweiler and Lanzer 1994, Santos 2000); Capilla Caleu (Ohlweiler and Lanzer 1993, Santos 1994, Santos 2003a, Lanzer 1996). **Concepción**: (USNM 169953); Puente Los Robles, Itata River (Ohlweiler and Lanzer 1993, Ohlweiler and Lanzer 1994, Santos 2000); Bío-Bío River, sector Santa Fé (MZUC without number; Santos 2000); Estero Bella Vista, Tomé (Santos 2000); Estero Linga (MZUC 2502); San Pedro Lagoon (MZUC 121). **Coquimbo**: Cogoti River, El Tranque (MNHN 200789, USNM 599683, Biese 1948, Lanzer 1996, Santos 2003a); Estero La Rica, Los Peladeros (MNHN 6548, USNM 599686: lectotype and paralectotype of *A. gayanus maximus*; Biese 1948, Hubendick 1967, Lanzer 1996, Santos 2003a); Hacienda Las Tinajas, Cogotí River (MNHN 200788, MZUC 1075, USNM 599683, Ohlweiler and Lanzer 1993, Santos 2003a); Chalinga River, Quebrada Amarilla (MNHN 200763); Chalinga River, Zapallar (USNM 599685, Biese 1948, Lanzer

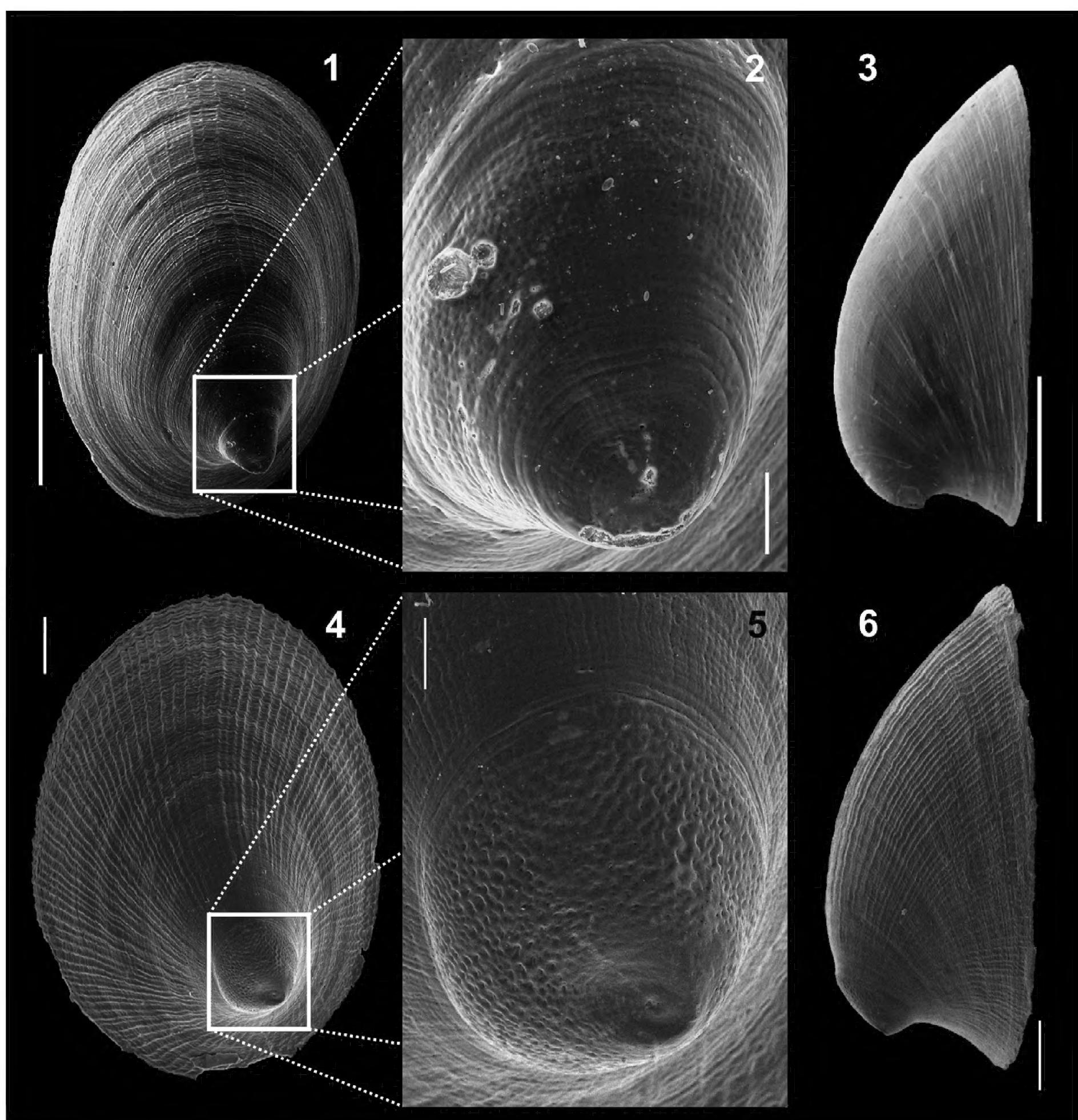
Table 1. Distribution of *Anisancylus* in South America by localities and countries.

Species	Catalogue number/Reference	Locality	Country
<i>A. obliquus</i>	Lanzer, 1996. Santos, 2000	Coquimbo region	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 2118. MHNNSC 200789, 200788. MZUC 1075. Biese, 1948. Lanzer, 1996. Santos, 2000	Cogoti River, El Tranque	Chile
<i>A. obliquus</i>	Lanzer, 1996	El Gaucho, Coquimbo	Chile
<i>A. obliquus</i>	MHNNSC 200785. Ohlweiler and Lanzer, 1993. Biese, 1948. Lanzer, 1996	Ester La Rica, Los Peladeros	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 87. MHNNSC 200760, 200761. MZUC 1072. Ohlweiler and Lanzer, 1993. Biese, 1948. Lanzer, 1996	Illapel, Coquimbo	Chile
<i>A. obliquus</i>	MHNNSC 200763. MZUC 178. Hubendick, 1967	Hacienda Las Tinajas	Chile
<i>A. obliquus</i>	MHNNSC 200762. Biese, 1948. Lanzer, 1996. Ohlweiler and Lanzer, 1993	Chalinga River, Quebrada Amarilla	Chile
<i>A. obliquus</i>	MHNNSC 200765. Lanzer, 1996	Chalinga River, La Brunina	Chile
<i>A. obliquus</i>	Ohlweiler and Lanzer, 1993	Huallilllinga	Chile
<i>A. obliquus</i>	MHNNSC 200764. Biese, 1948; Lanzer, 1996. Hubendick, 1967	Ovalle	Chile
<i>A. obliquus</i>	MHNNSC 200786. Biese, 1948. Lanzer, 1996. Hubendick, 1967	Limari River	Chile
<i>A. obliquus</i>	MHNNSC 200767. Lanzer, 1996	Choapa River	Chile
<i>A. obliquus</i>	MHNNSC 200768. MZUC 1076. Biese, 1948. Ohlweiler and Lanzer, 1993. Lanzer, 1996	Estero Consuelo	Chile
<i>A. obliquus</i>	MHNNSC 200769	Estero Camisas	Chile
<i>A. obliquus</i>	MHNNSC 200770	Grande River, Tulahuen	Chile
<i>A. obliquus</i>	MHNNSC 200771	Río Grande, Caren	Chile
<i>A. obliquus</i>	MHNNSC 200772	Mostazal River	Chile
<i>A. obliquus</i>	MHNNSC 200773. Lanzer, 1996	Pumpillos, Monte Patria	Chile
<i>A. obliquus</i>	Lanzer, 1996. Hubendick, 1967	San Felipe	Chile
<i>A. obliquus</i>	Lanzer, 1996	Quebrada Cimarrona, Bellavista	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 85	Región Metropolitana de Santiago	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 2116. MHNNSC 200778	Quebrada Córdoba	Chile
<i>A. obliquus</i>	MHNNSC 200777. Biese, 1948. Ohlweiler and Lanzer, 1993. Lanzer, 1996	Quebrada Calabozo, Til Til	Chile
<i>A. obliquus</i>	MHNNSC 200790. Ohlweiler and Lanzer, 1993. Lanzer, 1996	Estero la Dehesa, Barnechea	Chile
<i>A. obliquus</i>	Biese, 1948	Quebrada El Sause, Melon	Chile
<i>A. obliquus</i>	Biese, 1948	Mapocho River, Arrayan	Chile
<i>A. obliquus</i>	Biese, 1948	Cruces River, Valdivia	Chile
<i>A. obliquus</i>	Biese, 1948. Ohlweiler and Lanzer, 1993	Aconcagua River, Valparaiso	Chile
<i>A. obliquus</i>	Ohlweiler and Lanzer, 1993. Lanzer, 1996	Clarillo River, Santiago	Chile
<i>A. obliquus</i>	MHNNSC 200791, 200792	Estero Til Til	Chile
<i>A. obliquus</i>	MHNNSC 200793. Ohlweiler and Lanzer, 1993. Lanzer, 1996	Quebrada Arrayán, Santiago	Chile
<i>A. obliquus</i>	Lanzer, 1996	Peñaflor, Santiago	Chile
<i>A. obliquus</i>	MZUC 2502	Província Concepción	Chile
<i>A. obliquus</i>	Ohlweiler and Lanzer, 1993	Ester Linga, Concepción	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 40. MZUC s/ n°. Santos, 2000	Itata River	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 42. Santos, 2000	Bio-Bio River, Santa Fé	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 39. Santos, 2000. Ohlweiler and Lanzer, 1993	Bio-Bio River, Nacimiento	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 41. Santos, 2000	Puente los Robles	Chile
<i>A. obliquus</i>	MZUC 121	Ester Bella Vista	Chile
<i>A. obliquus</i>	Lanzer, 1996	Laguna San Pedro	Chile
<i>A. obliquus</i>	CMIOC 3901. Santos, 2000	Província Osorno	Chile
<i>A. obliquus</i>	Santos, 2000	Pilmaiquén	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 2114. MHNNSC 200796, 200794. MZUC 1077	Llanquihue province	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 2119. MHNNSC 201119	La Poza River	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 10574. Lanzer, 1996	Lago Llanquihue	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 35. Santos, 2000. Ohlweiler and Lanzer, 1993	Cajón del Maipo	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 36. Santos, 2000. Ohlweiler and Lanzer, 1994	Ester San Isidro	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 38. Santos, 2000	Ester San Pedro, Quillota	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 2115. MHNNSC 200774	Cau-Cau River	Chile
<i>A. obliquus</i>	MHNNSC 200775	Cuesta las Chilcas	Chile
<i>A. obliquus</i>	MHNNSC 200776	Los Castros, Alvarado	Chile
<i>A. obliquus</i>	MHNNSC 200782. Ohlweiler and Lanzer, 1993. Santos, 2000. Lanzer, 1996	Almendral, Cuesta la Dormida	Chile
<i>A. obliquus</i>	CMIOC 1058. Santos, 2000	Capilla Caleu	Chile
<i>A. obliquus</i>	MHNNSC 200781. MZUC 1073. Col. Mol. UERJ 2117. Ohlweiler and Lanzer, 1993. Santos, 2000	Viña del Mar	Chile
<i>A. obliquus</i>	Col. Mol. UERJ 37	Quebrada La Poza	Chile
<i>A. obliquus</i>	Ohlweiler and Lanzer, 1993	Ester Caleu	Chile
		Valparaíso	Chile

Continued

Table 1. *Continued.*

Species	Catalogue number/Reference	Locality	Country
<i>A. obliquus</i>	MNHNSC 200787. Lanzer, 1996	Quillota, Valparaíso	Chile
<i>A. obliquus</i>	Hubendick, 1967	Pucón	Chile
<i>A. obliquus</i>	Lanzer, 1996	Artigas	Uruguay
<i>A. obliquus</i>	Ohlweiler and Lanzer, 1993	Colonia	Uruguay
<i>A. obliquus</i>	Lanzer, 1996	Treinta y Tres	Uruguay
<i>A. obliquus</i>	Lanzer, 1996; Ohlweiler and Lanzer, 1993	Río Negro	Uruguay
<i>A. obliquus</i>	USNM 151664. ANSP 69729; 71267. Scarabino, 2004	San Gabriel Island	Uruguay
<i>A. obliquus</i>	Col. Mol. UERJ 34	Lavaleja	Uruguay
<i>A. obliquus</i>	Col. Mol. UERJ 2095	Arroyo Laureles, Tacuarembó	Uruguay
<i>A. obliquus</i>	MNHNM 4989. Santos, 2000	Arroyo Tres Cruces	Uruguay
<i>A. obliquus</i>	MNHNM 5639. Santos, 2000	Cuaró Grande, "Porvenir S.A."	Uruguay
<i>A. obliquus</i>	MNHNM 5071	Puntas Tres Cruces Grandes	Uruguay
<i>A. obliquus</i>	MNHNM 5592	Río Cuapeim	Uruguay
<i>A. obliquus</i>	MNHNM 5688. Santos, 2000	Estancia San Juan, Río Queguay	Uruguay
<i>A. obliquus</i>	Lanzer, 1996	San Carlos, Maldonado	Uruguay
<i>A. obliquus</i>	Lanzer, 1996	Callao	Peru
<i>A. obliquus</i>	Lanzer, 1996	Río Negro	Peru
<i>A. obliquus</i>	Ovando et al. 2014	Cabana, Córdoba	Argentina
<i>A. obliquus</i>	Ovando et al. 2014	Río Reartes, Córdoba	Argentina
<i>A. obliquus</i>	Ovando et al. 2014	Las Rosas, Primero River, Córdoba	Argentina
<i>A. obliquus</i>	IFML 16269. Col. Mol BDAD 195	Los Reartes	Argentina
<i>A. obliquus</i>	Ovando et al. 2014	Calamuchita, Córdoba	Argentina
<i>A. obliquus</i>	Ovando et al. 2014	Primero River, Córdoba	Argentina
<i>A. obliquus</i>	Col. Mol. BDAD 167. Ovando et al. 2014	Yacanto stream	Argentina
<i>A. obliquus</i>	Ovando et al. 2014	La Tablada, Río Primero, Córdoba	Argentina
<i>A. obliquus</i>	Ovando et al. 2014	San Roque River, Córdoba	Argentina
<i>A. obliquus</i>	Rumi et al. 2008	Río Negro	Argentina
<i>A. obliquus</i>	Ovando et al. 2014	El Niño stream, San Carlos de Bariloche	Argentina
<i>A. obliquus</i>	IFML 16267. Col. Mol. BDAD 191. Ovando et al. 2014	Anisacate River, Córdoba	Argentina
<i>A. obliquus</i>	IFML 16268. Col. Mol. BDAD 193. Ovando et al. 2014	La Cumbrecita, del Medio River, Córdoba	Argentina
<i>A. obliquus</i>	CMIOC 1903	Collón Cura River, Piedra del Águilla, Neuquén	Argentina
<i>A. obliquus</i>	CMIOC 1912	San Martín de los Andes, Neuquén Province, Argentina	Argentina
<i>A. obliquus</i>	MNHNM 5598, 5599. Santos, 2000	Paso del Parque	Argentina
<i>A. obliquus</i>	Lanzer, 1996. Simone, 2006	Santana do Livramento, Rio Grande do Sul	Brazil
<i>A. obliquus</i>	Ohlweiler and Lanzer, 1993	Ibirapuitã River, Santana do Livramento	Brazil
<i>A. obliquus</i>	Lanzer, 1996. Ohlweiler and Lanzer, 1993	Quaraí (Arroio do Chapéu, Coxilla São Rafael, Cerro do Chapéu, Estância São Roberto)	Brazil
<i>A. obliquus</i>	Lanzer, 1996. Ohlweiler and Lanzer, 1993	Alegrete, Rio Grande do Sul	Brazil
<i>A. obliquus</i>	Lanzer, 1996. Ohlweiler and Lanzer, 1993	Ibicui River, Encosta do Planalto, Rio Grande do Sul	Brazil
<i>A. obliquus</i>	Col. Mol. UERJ 11196	Foz do Iguaçu, M'Boicy River, Paraná	Brazil
<i>A. obliquus</i>	Col. Mol. UERJ 111181	Medianeira, Paraná	Brazil
<i>A. obliquus</i>	Col. Mol. UERJ 111171	Tucano stream, Santa Terezinha de Itaipú	Brazil
<i>A. dutrae</i>	Col. Mol. UERJ 32. Santos, 1994	Riacho Pascoal, Custódia, Pernambuco	Brazil
<i>A. dutrae</i>	Col. Mol. UERJ 28. Santos, 1994	Poço da Cruz, Ibimirim, Pernambuco	Brazil
<i>A. dutrae</i>	Col. Mol. UERJ 1534	Brejo dos Cavalos, Caruarú, Pernambuco	Brazil
<i>A. dutrae</i>	Col. Mol. Lucena 351	Gravatá, Pernambuco	Brazil
<i>A. dutrae</i>	Col. Mol. Lucena 538	Capibaribe River, Pau d'Alho, Pernambuco	Brazil
<i>A. dutrae</i>	Col. Mol. UERJ 33. Santos, 1994	Sanharó, Pernambuco	Brazil
<i>A. dutrae</i>	Santos, 1994	São José do Jacuípe, Jacobina	Brazil
<i>A. dutrae</i>	Col. Mol. UERJ 10404	Ceará, Baturité	Brazil
<i>A. dutrae</i>	Col. Mol. UERJ 10419	Minas Gerais, Lassance	Brazil
<i>A. dutrae</i>	Col. Mol. UERJ 27	Estação Ecológica do Tapacurá, São Lourenço da Mata, Pernambuco	Brazil
<i>A. dutrae</i>	Col. Mol. Lucena 631	Jaguaribe River, Sobreiro, Ceará	Brazil
<i>A. dutrae</i>	Col. Mol. UERJ 11367	Sucuri River, Bonito, Mato Grosso do Sul	Brazil



Figures 1–6. Specimens of *Anisancylus* used in this study. **1–3.** *Anisancylus obliquus*. **1.** Dorsal view showing general shell morphology. Scale bar: 500 µm. **2.** Detail of protoconch showing micro sculpture. Scale bar: 100 µm. **3.** Lateral view. Scale bar: 500 µm. **4–6.** *Anisancylus dutrae*. Scale bar: 500 µm.

1993, Lanzer 1996, Santos 2003a); Choapa River, Estero Camisas (MNHNSC 200768, Biese 1948, Ohlweiler and Lanzer 1993); Estero Camisas, Los Peladeros (Col. Mol. MZUC 1076); Grande River, Tulahuen (MNHNSC 200769); Grande River, Caren (MNHNSC 200770); Mostazal River, Caren (MNHNSC 200771); Pumpilllos, Monte Patria (MNHNSC 200772); El Gaucho (MNHNSC 200786, Ohlweiler and Lanzer 1993, Lanzer 1996); Illapel, Illapel River (Biese 1948, Ohlweiler and Lanzer 1993, Lanzer 1996); Mina Llamuco (Biese 1948, Ohlweiler and Lanzer 1993, Lanzer 1996); Huallillinga, Ovalle (Ohlweiler and Lanzer 1993, Lanzer 1996, Santos 2003a); Limari River, Ovalle (Biese 1948, Hubendick

1967, Lanzer 1996, USNM 599682); Choapa River, Salamanca (Biese 1948, Lanzer 1996, Santos 2003a); Estero Consuelo, Salamanca (Lanzer 1996, Santos 2003a); Quebrada Cimarrona, Bellavista, San Felipe, Aconcagua (USNM 599687, Hubendick 1967, Lanzer 1996, Santos 2003a); Chalinga River (USNM 599685, Hubendick 1967, Santos 2003a). **Santiago:** Estero la Dehesa, Barnechea (Biese 1948, Ohlweiler and Lanzer 1993, Lanzer 1996, Santos 2003a); Quebrada El Sauce, Melon (Ohlweiler and Lanzer 1993, Lanzer 1996, Santos 2003a); Clarillo River (Ohlweiler and Lanzer 1994); Estero Til-Til (Ohlweiler and Lanzer 1993, Lanzer 1996, Santos 2003a); Peñaflor (Biese 1948, Ohlweiler and

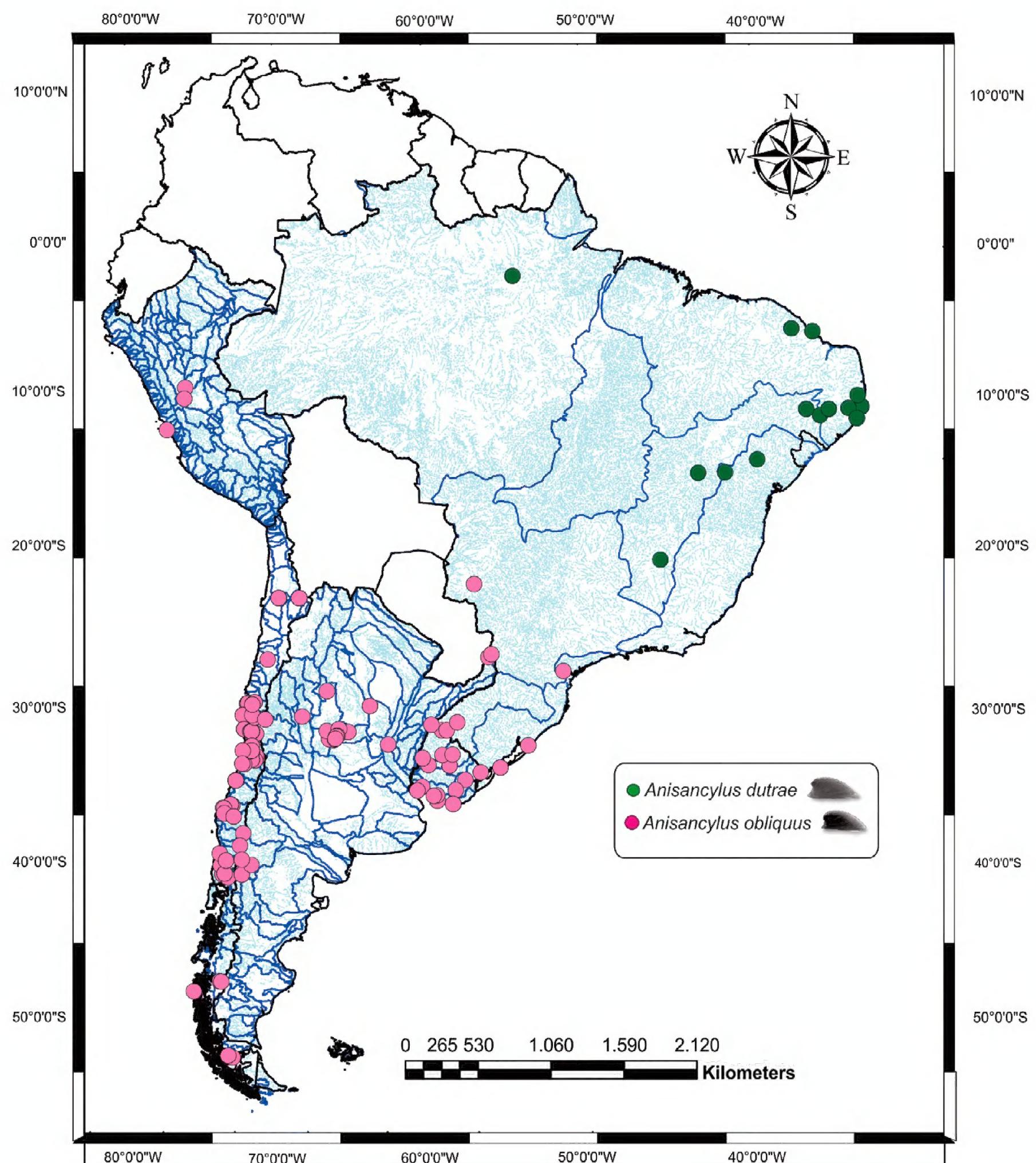


Figure 7. Distribution map showing the localities of *Anisancylus* species in South America: *Anisancylus obliquus* (pink points) and *A. dutrae* (green points).

Lanzer 1993, Lanzer 1996, Santos 2003a); Til-Til, Quebrada La Poza (Ohlweiler and Lanzer 1993, Santos 2000, Santos 2003a); Mapocho River, Arrayán (Biese 1948). **Llanquihue** (Santos 2000): Llanquihue Lake (MNHNSC 200796, MNHNSC 200794, MZUC 1077); Llanquihue Lake, Puerto Chico (MNHNSC 201119). **Maipo**: Cajúndel, Esterco (Lanzer 1996). **Osorno**: Pilmaiquén (Lanzer 1996, Santos 2000). **Pucón** (Hubendick 1967): Villarica Lake (USNM 529463). **Valdivia**: Cruces River (Biese 1948); Cau-Cau River, Teja island (Santos 2000). **Valparaíso**: Aconcagua River, Valparaíso (Biese 1948); Viña Del Mar (Ohlweiler and Lanzer 1993, Santos 2000); Quillota (holotype of *A. g. rudolfii*) (Biese 1948, Lanzer

1996, Santos 2003a). **San Felipe de Aconcagua**: Chal-linga River (MZUC 178); Cuesta las Chilcas, Llay-lhay (MNHNSC 200774); Los Castros, Alvarado (MNHNSC 200775); Almendral, Cuesta la Dormida, Valparaíso (MNHNSC 200776). **PERU**: Lima (USNM 126392); Callao; Río Negro (Ohlweiler and Lanzer 1993, Lanzer 1996). **URUGUAY**: **Artigas**: Salto (Lanzer 1996); Puntas Tres Cruces Grandes (MNHNM 5071); Tres Cruces stream (Santos 2000, Ohlweiler and Lanzer 1993); Cuaró Grande, “Porvenir S. A.” (Santos 2000); Cuapeim River (Santos 2000). **Treinta y Tres**: Los Cuervos (Ohlweiler and Lanzer 1993, Lanzer 1996). **Río Negro** (Ohlweiler and Lanzer 1993, Lanzer 1996). **Canelones** (Figueiras

1964). **Colonia:** Río de la Plata, San Gabriel Island (USNM 151664, ANSP 71267, ANSP 69729, Pilsbry and Rush 1896, Scarabino 2004); Colonia (Ohlweiler and Lanzer 1993). **Maldonado** (Barattini 1951). **Paysandú:** Estancia San Juan, Queguay River (Santos 2000). **Montevideo** (Pilsbry and Rush 1896, Pilsbry 1924). **Salto:** Dayman River, Paso del Parque (Ohlweiler and Lanzer 1993). **San José** (Figueiras 1964, Ohlweiler and Lanzer 1993, Lanzer 1996).

Material examined. **CHILE:** **Coquimbo:** Cogoti River, El Tranque (Col. Mol. UERJ 2118); Hacienda Las Tinajas, Cogotí River (Col. Mol. UERJ 87). **Santiago:** Quebrada Córdoba (Col. Mol. UERJ 85); Quebrada Calabozo, Til-Til (Col. Mol. UERJ 2116); Quebrada La Poza, Til-Til (Col. Mol. UERJ 2117); Til-Til, Estero Caleu (Col. Mol. UERJ 37); **Llanquihue:** La Poza River, Llanquihue Lake (Col. Mol. UERJ 2114); Llanquihue Lake, Puerto Chico (Col. Mol. UERJ 2119). **San Felipe de Aconcagua:** Cuesta las Chilcas, Llay-lay (Col. Mol. UERJ 2115). **BRAZIL:** **Paraná:** Medianeira (Col. Mol. UERJ 11181); Santa Terezinha de Itaipú, Tucano stream (Col. Mol. UERJ 11171); Foz do Iguaçu, M'Boicy River (Col. Mol. UERJ 11196). **URUGUAY** (Col. Mol. UERJ 88- 89): **Lavalleja:** Laureles stream, Rincón de Vassouras (Col. Mol. UERJ 34). **Tacuarembó** (Col. Mol. UERJ 2095).

Remarks. This species is widely distributed in the main basins of southern South America. In Argentina, this species was recorded from numerous central and southern localities (Córdoba and Río Negro provinces, attached to large stones in shallow rivers with stony substrates), Chile and Uruguay.

Anisancylus dutrae (Santos, 1994)

Gundlachia dutrae Santos 1994: 153.

Anisancylus dutrae — Santos 2003b: 205; Simone 2006: 112.

External features. Patelliform, high and elongated shell. Apex projected and inclined towards the right side and posteriorly. Apex sculpture with irregular pits and central apical depression (Figs 4–6). Animal with right anterior muscular scar elongated, surpassing the midline of the body, the anterior elongated and posterior left rounded. Mantle pigmentation varies from dark brown to black. Radula: rachidian tooth elongated, with 1 or 2 principal cusps generally one more elongated than the other (Santos 1994).

Type locality. Estação Ecológica do Tapacurá, São Lourenço da Mata, Pernambuco state, Brazil.

Distribution (Fig. 7). **BRAZIL:** **Pernambuco:** São Lourenço da Mata (Santos 1994), Riacho Pascoal, Custódia (Santos 1994); Poço da Cruz, Salgadinho, Recife (Santos 1994); Ibimirim (Santos 1994); Sanharó (Santos 1994); Sirinhaém River, Ribeirão (Col. Mol. UERJ). **Bahia** (Santos 2003b; Simone 2006): São José do Jacuípe, Jacobina (Santos 1994). **Mato Grosso do Sul:** Sucuri

River, Bonito (Col. Mol. UERJ).

Material examined. **BRAZIL:** **Ceará:** Baturité (Col. Mol. UERJ 10404); Jaguaribe, Sobreiro (CMIOC ex Col. Lucena 631). **Minas Gerais:** Lassance, São Gonçalo River, 21/07/2013, Lacerda LE, Gonçalves IC, Ximenes R col. (Col. Mol. UERJ 10419). **Mato Grosso do Sul:** Sucuri River, Bonito, Camargo R col. (Col. Mol. UERJ 11357). **Pernambuco:** Riacho Pascoal, Custódia (Col. Mol. UERJ 32); Poço da Cruz, Ibimirim (Col. Mol. UERJ 28); Brejo dos Cavalos, Caruarú (Col. Mol. UERJ 1534); Gravatá (CMIOC ex Col. Lucena 351); Capibaribe River, Pau d'Alho (CMIOC ex Col. Lucena 538); Sanharó (Col. Mol. UERJ 33); stream in Alto da Buchada Forest, Estação Ecológica do Tapacurá, São Lourenço da Mata (Col. Mol. UERJ 27); Sirinhaém River, Sirinhaém, 09/02/2006, Franklin N col. (Col. Mol. UERJ 11238).

Discussion

This work provides a distribution summary of *Anisancylus* in South America. The northernmost point of the occurrence corresponds to *A. dutrae* in Brazil (Baturité, Ceará state) while the southernmost corresponds to *A. obliquus* in Chile (Grande River, Tulahuen, Coquimbo region). We recorded new localities of *A. dutrae* in the states of Ceará and Pernambuco and for first time this species is recorded in Minas Gerais (Lassance) and Mato Grosso do Sul (Bonito), extending the known distribution of this species to the southeast. Previous records of *A. dutrae* were located in the São Francisco river basin (the same basin where we found the new record in Lassance). The São Francisco River runs generally north in the states of Minas Gerais and Bahia, before turning east to form the border between Bahia on the right bank and Pernambuco (type locality of *A. dutrae*) and Alagoas states on the left bank (Simpson 1999). This basin has a high level of endemism (mainly fishes and birds) and has significant biogeographical interest (Camelier and Zanata 2014). One possible hypothesis to explain the presence of *A. dutrae* in Minas Gerais could be passive dispersal by fishes or birds (Green and Figueroa 2005, Kappes and Haase 2012).

On the other hand, *A. obliquus* has records in Chile, Peru, central and southern Argentina, Uruguay and Southern Brazil. In Argentina *A. obliquus* is distributed in 2 disjunct areas, the first one located in central and southern Córdoba province and the second located on the southwestern border of Río Negro and Neuquén provinces. The record of *A. obliquus* reported from an Andean Patagonian lake in Argentina by Ritossa and Gustavo (2014) is incorrect. The specimens they figured does not match the general shell morphology of *A. obliquus*. In Brazil, *A. obliquus* had been recorded only in Rio Grande do Sul state (Ohlweiler and Lanzer 1993, Lanzer 1996). Our results report for first time the presence of this species in the La Plata Basin system of Paraná state. The La Plata basin extending over territories belonging to

Argentina, Bolivia, Brazil, Uruguay and the whole of Paraguay, is the second largest drainage in South America (Berberry and Barros 2002). However, in our exhaustive bibliographic search and study of material from malacological collections, we did not find additional records of *A. obliquus* from other South American countries such as Bolivia and Paraguay.

The distribution of *Anisancylus* in South America shows peculiarities, and some hypotheses such as the tectonic evolution of the basins and the fossil record could explain this peculiar distribution. According to Leal (2011), part of the diversification of aquatic Neotropical biota resulted from the dynamics of rivers and watersheds during the Lower Cretaceous and Cenozoic. Vicariance processes and dispersion of this biota appear to have been mainly due to these events. Distribution patterns of some South American taxa such as fishes, ostracods and mollusks are examples of vicariance events (Leal 2011). Furthermore, the change of direction in the drainage and the establishment of its current pattern in the South American basins was the result of a series of tectonic processes, including the uplift of the Andes Mountain Range (Brito et al. 2007). The sea level fluctuations related to the glacial cycles of the Pliocene and Holocene also influenced on the hydrology of the South American basins (Leal 2011) together with the isolation of some Rivers and the formation of some lagoons (Hubert and Renno 2006, Ribeiro 2006).

The paleontological records show evidences about the presence of *Anisancylus* in freshwater environments in the past. *Gundlachia taguataguensis* Covacevich, 1971 [a nomen nudum] was described in lacunar facies of the Upper Pleistocene of San Vicente de Tagua Tagua, Chile. According Santos (2003b), this name corresponds with *A. obliquus*. For Uruguay, Olazarri (1988) mentioned *Ancylus gayanus* d'Orbigny, 1837 (= *Anisancylus obliquus*) in sediments of the Artigas Formation (Upper Pleistocene) and Martínez and Rojas (2004) cited this species as *A. obliquus* in the Sopas and Yucutujá formations.

Summarizing the tectonic processes, vicariance and dispersal (via animal transport) would explain the distribution patterns and the presence of *A. obliquus* in both sides of Andes. Additional studies are needed to understand these distributional patterns and affinities among the South American species of *Anisancylus*. Such studies must take an integrative approach by combining biogeographic and phylogeographic analyses, distribution modeling, and molecular systematics to allow inferences on the history of this genus and other Neotropical freshwater limpets.

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Authors' Contributions

SBS is responsible for the idea and the examination of most of material from malacological collections; XCO revised and collected material from Argentina; CSR and XCO georeferenced the data; XCO prepared the map; CSR prepared the images; XCO and SBS wrote the manuscript.

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